

FACT SHEET FOR STATE WASTE DISCHARGE PERMIT ST- 8075

MCCARY COUNTRY MEATS

This fact sheet is a companion document to the draft State Waste Discharge Permit No. 8075 for McCary Country Meats, Franklin County. The Department of Ecology (the Department) is proposing to issue this permit.

This fact sheet explains the regulatory and technical basis for the conditions contained in the permit. Public involvement information is contained in the Appendix.

GENERAL INFORMATION

Applicant: Herschel M. McCary

Facility Name
and Address: McCary Country Meats
21981 Glade Road North
Basin City, WA 99343

Type of
Treatment: Land Treatment System for slaughterhouse washdown water. Wastewater is discharged to a 2 cell wastewater lagoon and discharged to an adjacent land application site.

Facility
Location: 21981 Glade Road North
Basin City, WA 99343
NE¼, SE¼, Sec26, T.13 N., R.29 E.W.M.

Latitude: 46° 35' 00"N

Longitude: 119° 08' 07"W

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INTRODUCTION

This fact sheet is a companion document to the draft State Waste Discharge Permit No. **ST-8075**. The Department of Ecology (the Department) is proposing to issue this permit, which will allow discharge of wastewater to waters of the State of Washington. This fact sheet explains the nature of the proposed discharge, the Department's decisions on limiting the pollutants in the wastewater, and the regulatory and technical bases for those decisions.

Washington State law (RCW 90.48.080 and 90.48.162) requires that a permit be issued before discharge of wastewater to waters of the state is allowed. Regulations adopted by the State include procedures for issuing permits (Chapter 173-216 WAC), technical criteria for discharges from municipal wastewater treatment facilities (Chapter 173-221 WAC) and water quality criteria for ground waters (Chapter 173-200 WAC). They also establish the basis for effluent limitations and other requirements which are to be included in the permit.

This fact sheet and draft permit are available for review by interested persons as described in Appendix A--Public Involvement Information.

The fact sheet and draft permit have been reviewed by the Permittee. Errors and omissions identified in these reviews have been corrected before going to public notice. After the public comment period has closed, the Department will summarize the substantive comments and the response to each comment. The summary and response to comments will become part of the file on the permit and parties submitting comments will receive a copy of the Department's response. The fact sheet will not be revised. Changes to the permit will be addressed in Appendix D--Response to Comments

<u>GENERAL INFORMATION</u>	
Applicant	Herschel M. "Bud" McCary
Facility Name and Address	McCary Country Meats 21981 Glade Road North Basin City, WA 99343
Type of Treatment System:	Custom slaughterhouse
Discharge Location	Land Treatment System for slaughterhouse wash down water. Wastewater is discharged to a 2 cell wastewater lagoon and discharged to an adjacent land application site.
Legal Description of Application Area	Latitude: 46° 35' 00" N Longitude: 119° 08' 07" W.
Contact at Facility	NE¼, SE¼, Sec26, T.13 N., R.29 E.W.M.
Responsible Official	Name: Herschel M. McCary Telephone #: (509) 269-4488

BACKGROUND INFORMATION

DESCRIPTION OF THE COLLECTION AND TREATMENT SYSTEM

McCary's Country Meats is a custom slaughter operation located on approximately 14 acres, 1 mile southeast of the town of Basin City, in Franklin County, approximately 10 miles west of the town of Mesa and about 120 miles southwest of Spokane. A slaughterhouse, holding pens for animals, and lagoons and sprayfields for the treatment, storage and disposal of wastewater are located on the site. About 30 animals comprised of cattle, hogs and sheep will be processed each day. All solid waste and by-product will be hauled away. The wastewater is generated from the wash down of the slaughterhouse floor and equipment.

Building drains are comprised of four-inch cast iron piping with floor grate inlets and traps. There are two surface drain inlets from the outside holding pens which flow into the slaughterhouse wastewater system. After flowing through a grease trap, the wastewater gravity flows to lagoons.

HISTORY

This facility was a slaughterhouse prior to the McCary's ownership. The current operation uses pre-existing slaughterhouse facilities, but with added new wastewater units. The owner obtained the necessary permits from the County and from Ecology for the wastewater system before startup. Final construction of the wastewater system occurred in spring, 2001.

INDUSTRIAL TREATMENT PROCESSES

McCary's Country Meats is a custom slaughterhouse which processes a variety of animals that are brought onto the site. The animals are temporarily stored in a small wood corral connected to the slaughterhouse. The animals move from the corral into the slaughterhouse, where they are killed, eviscerated and prepared.

The viscera and most of the blood and other animal by-product, such as oil and grease is collected and sent to a rendering plant. A grease trap located between the slaughterhouse and the lagoons prevents entry of oil and grease into the lagoons. The wastewater is comprised primarily of washdown water from the daily cleaning of the floors.

The design daily flow rate is approximated at 6,000 gpd, based on an estimated 200 gpd per animal processed, with an estimated processing rate of 30 animals a day, 5 days per week. The proposed land application when in operation will occur only during the months of April through September, with 6 months of storage in the lagoon system.

TREATMENT PROCESSES

The wastewater flows by gravity from the slaughterhouse to a 1,500 gallon grease trap. From the grease trap, the flow continues another 250 feet and can be directed to either of two identical lagoons, with approximately 3 months hydraulic detention time apiece. After residing in the lagoons for up to 6 months, the effluent can be pumped to solid set sprinklers which are located on the east and to the south of the lagoons. The total phase 1 irrigation site is 2 acres. The

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proposed location for land treatment is initially 2 acres which could be expanded to a total of 5 acres of the two parcels owned by the McCary's, which together total the 14 acres of the site. At this time, there is only a fraction of this waste volume, and only 1 of the 2 lagoons is in use. Essentially, the treatment system is a non-overflow system.

DISTRIBUTION SYSTEM (SPRAYFIELD)

When land application of the treated wastewater occurs, it will operate under the following distribution system:

A solid set sprinkler system composed of buried two-three inch PVC manifold and header pipes covering an area of approximately two acres. The spray heads when in use, will be on risers, four feet above the ground surface. An irrigation and crop management plan will be developed for the site. There will be a minimum buffer of 50 feet between the furthest spray head and an adjacent county road on the east side of the property.

RESIDUAL SOLIDS

Any solids removed from the lagoon system will be land applied under a permit from the Benton-Franklin County Health District.

GROUND WATER

A preliminary ground water assessment was completed in early 2000. Approximately 50 test pits were dug. Seeping water was encountered in two of the pits. Five of the pits indicated that there was water between 2-3 feet below the surface recently. A shallow irrigation well is located at the northwest property corner. The static water in that well is only 5.5 feet below the surface.

The engineer inferred from this preliminary work that the ground water flow direction is generally northwest and is shallow.

For those facilities that have a limited potential to contaminate ground water, an extensive hydrogeologic study requirement can be waived. This permit will require that a wastewater characterization report be conducted in order to establish a baseline to compare future monitoring activities. Effluent monitoring will help evaluate whether or not ground water limits and long term ground water monitoring will be required. To date, flows are limited; the lined impoundments have never held enough wastewater to discharge to the cropland, therefore, this facility has been determined to have limited potential to contaminate ground water. Should production from this facility increase to the point that wastewater is being applied to the sprayfields the requirements for a more extensive hydrogeologic study will be re-evaluated.

PERMIT STATUS

The previous permit for this facility was issued on November 1, 2000.

An application for permit renewal was submitted to the Department on July 6, 2004 and accepted by the Department on July 12, 2004.

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SUMMARY OF COMPLIANCE WITH THE PREVIOUS PERMIT

The facility last received an inspection on October 16, 2003. During the history of the previous permit, the Permittee has not submitted Discharge Monitoring Reports (DMRs), and has interpreted monitoring as necessary only when spray application occurs. In fact, there is a need to monitor wastewater influent in the grease trap (lagoon influent) to develop baseline data for future discharge.

WASTEWATER CHARACTERIZATION

The concentration of pollutants in the discharge has not been reported. Wastewater data from the much larger IBP slaughterhouse located near Wallula was used to characterize slaughterhouse industry discharge. The following wastewater characterization is based on that information.

Table 1: Wastewater Characterization

<u>Parameter</u>	<u>Concentration</u>
Total Nitrogen	100mg/l
BOD	2,500 mg/l
Conductivity	1,100 Micromho/cm
TSS	900 mg/l

SEPA COMPLIANCE

SEPA was complied with in the original construction.

PROPOSED PERMIT LIMITATIONS

State regulations require that limitations set forth in a waste discharge permit must be either technology- or water quality-based. Wastewater must be treated using all known, available, and reasonable treatment (AKART) and not pollute the waters of the State. The minimum requirements to demonstrate compliance with the AKART standard are derived from the *Water Reclamation and Reuse Standards*, the *Design Criteria for Municipal Wastewater Land Treatment*, and Chapter 173-221 WAC.

The approved engineering report includes specific design criteria for this facility. Water quality-based limitations are based upon compliance with the Ground Water Quality Standards (Chapter 173-200 WAC).

The more stringent of the water quality-based or technology-based limits are applied to each of the parameters of concern. Each of these types of limits is described in more detail below.

TECHNOLOGY-BASED EFFLUENT LIMITATIONS

All waste discharge permits issued by the Department must specify conditions requiring available and reasonable methods of prevention, control, and treatment of discharges to waters

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of the state (WAC 173-216-110). The following permit limitations are necessary to satisfy the requirement for AKART:

GROUND WATER QUALITY-BASED EFFLUENT LIMITATIONS

In order to protect existing water quality and preserve the designated beneficial uses of Washington's ground waters including the protection of human health, WAC 173-200-100 states that waste discharge permits shall be conditioned in such a manner as to authorize only activities that will not cause violations of the Ground Water Quality Standards. Drinking water is the beneficial use generally requiring the highest quality of ground water. Providing protection to the level of drinking water standards will protect a great variety of existing and future beneficial uses.

Applicable ground water criteria as defined in Chapter 173-200 WAC and in RCW 90.48.520 for this discharge include the following:

Table 2: Ground Water Quality Criteria

Total Coliform Bacteria	1 Colony/ 100 mL
Total Dissolved Solids	500 mg/L
Chloride	250 mg/L
Sulfate	250 mg/L
Nitrate	10 mg/L
pH	6.5 to 8.5 standard units
Manganese	0.05 mg/L
Total Iron	0.3 mg/L
Toxics	No toxics in toxic amounts

The Department has reviewed existing records and is unable to determine if background ground water quality is either higher or lower than the criteria given in Chapter 173-200 WAC; therefore, the Department will use the criteria expressed in the regulation in the proposed permit. The discharges authorized by this proposed permit are not expected to interfere with beneficial uses.

Pollutant concentrations in the proposed discharge exceed ground water quality criteria with technology-based controls which the Department has determined to be AKART. A limit based on ground water criteria is established and applied at the end of treatment.

The resultant effluent limits are as follows:

Table 3: Water Quality-based Limitations.

Parameter	INFLUENT LIMITATIONS	
	Average Monthly ^a	Maximum Daily ^b

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	INFLUENT LIMITATIONS	
Parameter	Average Monthly ^a	Maximum Daily ^b
Flow	6,000 GPD	-----
	<i>EFFLUENT LIMITATIONS</i>	
Total Nitrogen ^c	-----	To be determined
^a The average monthly effluent limitation is defined as the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.		
^b The maximum daily effluent limitation is defined as the highest allowable daily discharge. The daily discharge means the discharge of a pollutant measured during a calendar day. For pollutants with limitations expressed in units of mass, the daily discharge is calculated as the total mass of the pollutant discharged over the day. For other units of measurement, the daily discharge is the average measurement of the pollutant over the day.		
^c Sum of organic nitrogen, ammonia, nitrite and nitrate		

COMPARISON OF LIMITATIONS WITH THE EXISTING PERMIT ISSUED

No valid upgradient background data were available for list pollutants. The Permittee is required in section S2 of the proposed permit to collect background concentrations near the point of discharge. This information may result in a permit modification or limits in the next renewal.

Table 4: Comparison of Previous and New Limits

Parameter	Existing Limits	Proposed Limits
BOD	100 lbs/day/acre	100 lbs/day/acre

MONITORING REQUIREMENTS

Monitoring, recording, and reporting are specified to verify that the treatment process is functioning correctly, that ground water criteria are not violated, and that effluent limitations are being achieved (WAC 173-216-110).

INFLUENT AND EFFLUENT MONITORING

The monitoring and testing schedule is detailed in the proposed permit under Condition S2. Specified monitoring frequencies take into account the quantity and variability of the discharge, the treatment method, past compliance, significance of pollutants, and cost of monitoring.

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Monitoring in the grease trap is being required to further characterize the effluent. These pollutant(s) could have a significant impact on the quality of the ground water.

CROP MONITORING

The monitoring schedule is detailed in the proposed permit under Condition S2.C. Specified monitoring frequencies take into account the quantity and variability of the discharge, the treatment method, past compliance, significance of pollutants, and cost of monitoring.

SOIL MONITORING

When land application of waste water occurs, the Permittee shall perform soil monitoring on the irrigated lands twice per year. Sampling sites shall be located so as to be representative of each irrigation site or as represented in the crop management plan. If possible, sampling sites shall remain in the same location in the field from year to year. Results shall be submitted annually with the annual Irrigation and Crop Management Plan.

Composite samples will be taken at one foot intervals from three depths (0-12"; 24-36"; 48-60") and will be from a minimum of four (4) cores per field. Samples will be collected at a time that best represents soil conditions at the beginning and end of the crop growing season.

The monitoring schedule is detailed in the proposed permit under Condition S2.B. Specified monitoring frequencies take into account the quantity and variability of the discharge, the treatment method, past compliance, significance of pollutants, and cost of monitoring.

OTHER PERMIT CONDITIONS

REPORTING AND RECORDKEEPING

The conditions of S3. are based on the authority to specify any appropriate reporting and recordkeeping requirements to prevent and control waste discharges (WAC 173-216-110).

FACILITY LOADING

The design criteria for this treatment facility are taken from October 27, 2001 engineering report prepared by Harms & Associates and are as follows:

Monthly average flow (max. month):	6,000 GPD
Nitrogen effluent loading	0.1ppm
BOD effluent loading:	100 lbs/day/acre

The permit requires the Permittee to maintain adequate capacity to treat the flows and waste loading to the treatment plant (WAC 173-216-110[4]). The Permittee is required to submit an engineering report when the plant reaches 85% of its flow or loading capacity. For significant new discharges, the permit requires a new application and an engineering report (WAC 173-216-110[5]).

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IRRIGATION AND CROP MANAGEMENT PLANS

The irrigation and crop management plan is required to support the engineering report(s) and operations and maintenance manual. This plan shall include a consideration of wastewater application at agronomic rates and should describe and evaluate various irrigation controls.

OPERATIONS AND MAINTENANCE

The proposed permit contains condition S5. as authorized under RCW 90.48.110, WAC 173-220-150, Chapter 173-230 WAC, and WAC 173-240-080. It is included to ensure proper operation and regular maintenance of equipment, and to ensure that adequate safeguards are taken so that constructed facilities are used to their optimum potential in terms of pollutant capture and treatment.

RESIDUAL SOLIDS HANDLING

To prevent water pollution the Permittee is required in permit condition S6. to store and handle all residual solids (grit, screenings, scum, sludge, and other solid waste) in accordance with the requirements of RCW 90.48.080 and State Water Quality Standards.

The final use and disposal of sewage sludge from this facility is regulated by U.S. EPA under 40 CFR 503 and by Ecology under Chapter 70.95J RCW and Chapter 173-208 WAC. The disposal of other solid waste is under the jurisdiction of the local health district.

Requirements for monitoring sewage sludge and recordkeeping are included in this permit. This information will be used by Ecology to develop or update local limits and is also required under 40 CFR 503.

GENERAL CONDITIONS

General Conditions are based directly on state laws and regulations and have been standardized for all industrial waste discharge to ground water permits issued by the Department.

Condition G1 requires responsible officials or their designated representatives to sign submittals to the Department. Condition G2 requires the Permittee to allow the Department to access the treatment system, production facility, and records related to the permit. Condition G3 specifies conditions for modifying, suspending or terminating the permit. Condition G4 requires the Permittee to apply to the Department prior to increasing or varying the discharge from the levels stated in the permit application. Condition G5 requires the Permittee to submit written notice of significant increases in the amount or nature of discharges (typically new industrial discharges) into the sewer system tributary to the permitted facility. Condition G6 requires the Permittee to construct, modify, and operate the permitted facility in accordance with approved engineering documents. Condition G7 prohibits the Permittee from using the permit as a basis for violating any laws, statutes or regulations. Condition G8 requires application for permit renewal 60 days prior to the expiration of the permit. Condition G9 requires the payment of permit fees. Condition G10 describes the penalties for violating permit conditions.

RECOMMENDATION FOR PERMIT ISSUANCE

This proposed permit meets all statutory requirements for authorizing a wastewater discharge, including those limitations and conditions believed necessary to control toxics, and to protect human health and the beneficial uses of waters of the State of Washington. The Department proposes that the permit be issued for 5 years.

REFERENCES FOR TEXT AND APPENDICES

Faulkner, S.P., Patrick Jr., W.H., Gambrell, R.P., May-June, 1989. Field Techniques for Measuring Wetland Soil Parameters, Soil Science Society of America Journal, Vol. 53, No.3.

Washington State Department of Ecology, 1993. Guidelines for Preparation of Engineering Reports for Industrial Wastewater Land Application Systems, Ecology Publication # 93-36. 20 pp.

Washington State Department of Ecology and Department of Health, 1997. Water Reclamation and Reuse Standards, Ecology Publication # 97-23. 73 pp.

Washington State Department of Ecology.

Laws and Regulations(<http://www.ecy.wa.gov/laws-rules/index.html>)

Permit and Wastewater Related Information
(<http://www.ecy.wa.gov/programs/wq/wastewater/index.html>)

Washington State Department of Ecology, 1996. Implementation Guidance for the Ground Water Quality Standards, Ecology Publication # 96-02.

Washington State University, November, 1981. Laboratory Procedures - Soil Testing Laboratory. 38 pp.

APPENDICES

APPENDIX A--PUBLIC INVOLVEMENT INFORMATION

The Department has tentatively determined to reissue a permit to the applicant listed on page one of this fact sheet. The permit contains conditions and effluent limitations which are described in the rest of this fact sheet.

Public notice of application was published on June 13 and June 20, 2003 in the Tri-City Herald to inform the public that an application had been submitted and to invite comment on the reissuance of this permit.

This permit was written by Wayne Peterson and Marcie Mangold.

APPENDIX B--GLOSSARY

Ambient Water Quality--The existing environmental condition of the water in a receiving water body.

Ammonia--Ammonia is produced by the breakdown of nitrogenous materials in wastewater. Ammonia is toxic to aquatic organisms, exerts an oxygen demand, and contributes to eutrophication. It also increases the amount of chlorine needed to disinfect wastewater.

Average Monthly Discharge Limitation--The average of the measured values obtained over a calendar month's time.

Best Management Practices (BMPs)--Schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the State. BMPs include treatment systems, operating procedures, and practices to control: plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. BMPs may be further categorized as operational, source control, erosion and sediment control, and treatment BMPs.

BOD₅--Determining the Biochemical Oxygen Demand of an effluent is an indirect way of measuring the quantity of organic material present in an effluent that is utilized by bacteria. The BOD₅ is used in modeling to measure the reduction of dissolved oxygen in a receiving water after effluent is discharged. Stress caused by reduced dissolved oxygen levels makes organisms less competitive and less able to sustain their species in the aquatic environment. Although BOD is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.

Bypass--The intentional diversion of waste streams from any portion of the collection or treatment facility.

Chlorine--Chlorine is used to disinfect wastewaters of pathogens harmful to human health. It is also extremely toxic to aquatic life.

Compliance Inspection - Without Sampling--A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes and regulations.

Compliance Inspection - With Sampling--A site visit to accomplish the purpose of a Compliance Inspection - Without Sampling and as a minimum, sampling and analysis for all parameters with limits in the permit to ascertain compliance with those limits; and, for municipal facilities, sampling of influent to ascertain compliance with the 85 percent removal requirement. Additional sampling may be conducted.

Composite Sample--A mixture of grab samples collected at the same sampling point at different times, formed either by continuous sampling or by mixing discrete samples. May be "time-composite"(collected at constant time intervals) or "flow-proportional" (collected either as a constant sample volume at time intervals proportional to stream flow, or collected by increasing the volume of each aliquot as the flow increased while maintaining a constant time interval between the aliquots.

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Construction Activity--Clearing, grading, excavation and any other activity which disturbs the surface of the land. Such activities may include road building, construction of residential houses, office buildings, or industrial buildings, and demolition activity.

Continuous Monitoring --Uninterrupted, unless otherwise noted in the permit.

Distribution Uniformity--The uniformity of infiltration (or application in the case of sprinkle or trickle irrigation) throughout the field expressed as a percent relating to the average depth infiltrated in the lowest one-quarter of the area to the average depth of water infiltrated.

Engineering Report--A document, signed by a professional licensed engineer, which thoroughly examines the engineering and administrative aspects of a particular domestic or industrial wastewater facility. The report shall contain the appropriate information required in WAC 173-240-060 or 173-240-130.

Fecal Coliform Bacteria--Fecal coliform bacteria are used as indicators of pathogenic bacteria in the effluent that are harmful to humans. Pathogenic bacteria in wastewater discharges are controlled by disinfecting the wastewater. The presence of high numbers of fecal coliform bacteria in a water body can indicate the recent release of untreated wastewater and/or the presence of animal feces.

Grab Sample--A single sample or measurement taken at a specific time or over as short period of time as is feasible.

Industrial Wastewater--Water or liquid-carried waste from industrial or commercial processes, as distinct from domestic wastewater. These wastes may result from any process or activity of industry, manufacture, trade or business, from the development of any natural resource, or from animal operations such as feed lots, poultry houses, or dairies. The term includes contaminated storm water and, also, leachate from solid waste facilities.

Maximum Daily Discharge Limitation--The highest allowable daily discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. The daily discharge is calculated as the average measurement of the pollutant over the day.

Method Detection Level (MDL)--The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is above zero and is determined from analysis of a sample in a given matrix containing the analyte.

pH--The pH of a liquid measures its acidity or alkalinity. A pH of 7 is defined as neutral, and large variations above or below this value are considered harmful to most aquatic life.

Quantitation Level (QL)-- A calculated value five times the MDL (method detection level).

Soil Scientist--An individual who is registered as a Certified or Registered Professional Soil Scientist or as a Certified Professional Soil Specialist by the American Registry of Certified Professionals in Agronomy, Crops, and Soils or by the National Society of Consulting Scientists or who has the credentials for membership. Minimum requirements for eligibility are: possession of a baccalaureate, masters, or doctorate degree from a U.S. or Canadian institution with a minimum of 30 semester hours or 45 quarter hours professional core courses in agronomy,

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crops or soils, and have 5,3,or 1 years, respectively, of professional experience working in the area of agronomy, crops, or soils.

State Waters--Lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and watercourses within the jurisdiction of the state of Washington.

Stormwater--That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a storm water drainage system into a defined surface water body, or a constructed infiltration facility.

Technology-based Effluent Limit--A permit limit that is based on the ability of a treatment method to reduce the pollutant.

Total Coliform Bacteria--A microbiological test which detects and enumerates the total coliform group of bacteria in water samples.

Total Dissolved Solids--That portion of total solids in water or wastewater that passes through a specific filter.

Total Suspended Solids (TSS)--Total suspended solids is the particulate material in an effluent. Large quantities of TSS discharged to a receiving water may result in solids accumulation. Apart from any toxic effects attributable to substances leached out by water, suspended solids may kill fish, shellfish, and other aquatic organisms by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids can screen out light and can promote and maintain the development of noxious conditions through oxygen depletion.

Water Quality-based Effluent Limit--A limit on the concentration of an effluent parameter that is intended to prevent pollution of the receiving water.

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APPENDIX C--TECHNICAL CALCULATIONS

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APPENDIX D--RESPONSE TO COMMENTS